

Contribution to the bryological knowledge of the Tuscan-Emilian Apennines (Northern Italy)

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Abstract

The inventory of the bryophytes collected during the annual excursion of the Working Group for Bryology of the Italian Botanical Society is reported. This excursion was held in 2018 on the northern slope of the Tuscan-Emilian Apennines National Park, in the Administrative Region of Emilia-Romagna. The field work led to the finding of 113 taxa (24 liverworts and 89 mosses), including eight new records and seven confirmations for this Region. The occurrence of rare taxa for Italy (*Scapania uliginosa*, *Rhizomnium pseudopunctatum*, *Racomitrium fasciculare*, *Scorpidium cossonii*, *Grimmia lisae*, *Orthotrichum pulchellum*) is highlighted.

Keywords

Bryophytes, new floristic records, northern Apennines, regional flora

Introduction

The Tuscan-Emilian Apennines constitute the central sector of the northern Apennines, a mountain chain that crosses the Italian peninsula along the border between the Administrative Regions of Emilia-Romagna and Toscana.

The first knowledge on the bryophyte flora of the Tuscan-Emilian Apennines dates back to the end of the 19th century with the floristic contributions of Fiori (1886, 1892a, 1892b), Avetta (1897), Casali (1899a, 1899b), and Provasi (1938), regarding the moss and liverwort flora of the provinces of Modena, Reggio Emilia, and Parma. Other information is found in the papers published by Barsali (1907, 1914) and Bottini (1913, 1914, 1919); later, Raffaelli (1976) published a paper on the genus *Sphagnum* for the Tuscan-Emilian territory. More data can be drawn from the phytogeographic and phytosociological papers of Tomaselli and Gerdol (1984), Gerdol and Tomaselli (1988, 1993), Tomaselli (1991), and Petraglia and Tomaselli (2007). Recently, a study on the bryoflora of the gypsum outcrops (Aleffi et al. 2014) and a checklist of the bryophytes of Emilia-Romagna (Fariselli et al. 2019) were published. Nevertheless, knowledge on the bryophyte flora of the northern Apennines is not yet comprehensive; therefore, the annual excursion of the Working Group for Bryology of the Italian Botanical Society was organized in July 2018 in the National Park of the Tuscan-Emilian Apennines, where many different types of mountain habitats with an interesting bryophyte flora were investigated.

Study area

The Tuscan-Emilian Apennines represent the core district of the northern Apennines, a 250 km-long mountain barrier running in a NW-SE direction and separating the Po plain in the north from the rest of the Italian peninsula in the south (Fig. 1). The geological framework of the Tuscan-Emilian Apennines is mainly given by sandstones belonging to the Macigno Formation and by the Ligurian units, represented by successions characterized by helminthoid flysch deposits and sedimentary mélanges with blocks of ophiolite rocks (Bruni et al. 1994). Climatic features of the study area were obtained from the thermo-pluviometric data of six stations located above 1,000 m a.s.l. The mean annual precipitation is around 1500 mm, the mean annual temperature is about 5 °C with the mean monthly temperature ranging between 7 °C and 13 °C. July is the warmest month with a mean daily maximum of about 16 °C; February is the coldest one with a mean daily minimum of -2 °C.

The study area is located in the Emilian slope of the northern Apennines. It is characterized by a sub-Mediterranean vegetation belt dominated by xerophilous or mesophilous deciduous woodlands extending up to about 1,000 m a.s.l.; the montane belt is represented by different types of beech woodlands (Ubaldi et al. 1993). Its upper limit ranges between 1,600 and 1,700 m a.s.l., where it is strongly dependent upon geomorphological and land use conditions.

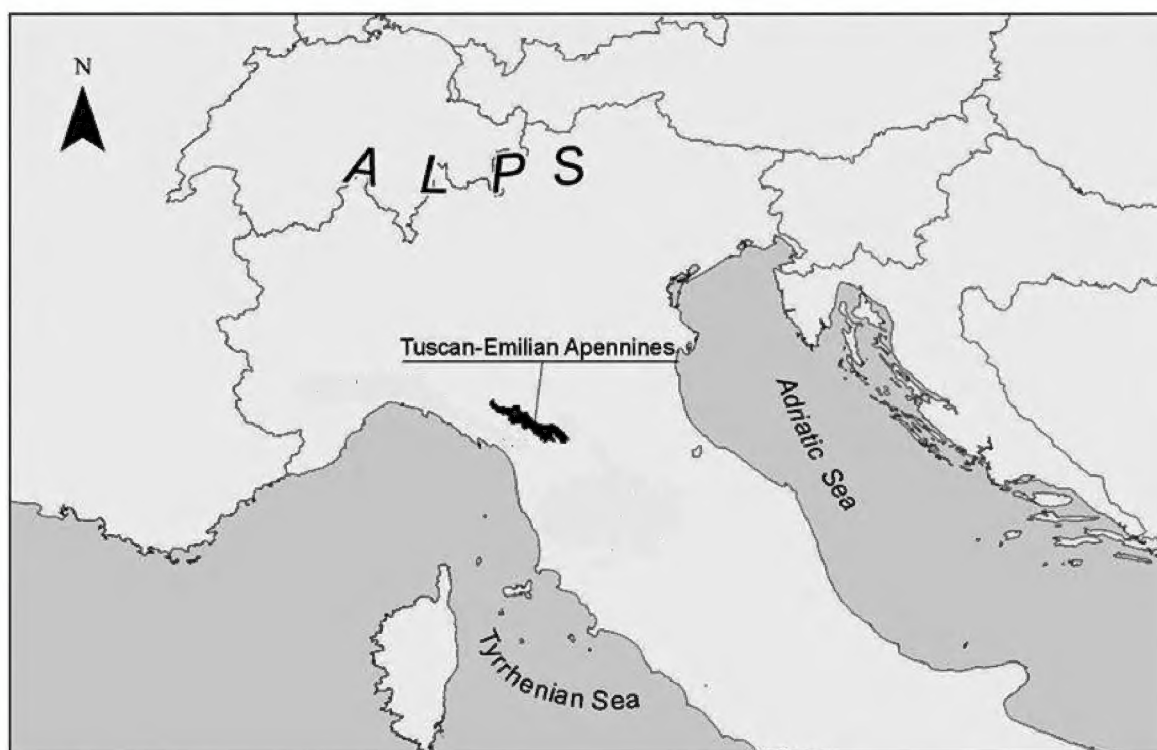


Figure 1. Schematic map of the study area.

Subalpine vegetation above the treeline is characterized by heathlands dominated by *Vaccinium* species (*V. myrtillus* L., *V. gaultherioides* Bigelow and *V. vitis-idaea* L.) and by *Empetrum hermaphroditum* Hagerup; they represent the most widespread vegetation type in the summit areas (Ferrari and Piccoli 1997). Intermixed with shrub heathlands and above the ridges and summits, a patchy mosaic of snow-beds (Petraglia and Tomaselli 2007), cryoxerophytic and mesophytic primary grasslands (Tomaselli et al. 2000), secondary grasslands (Gennai et al. 2014) and vegetation on rock faces and cliffs (Tomaselli et al. 2019) compose the landscape of the Tuscan-Emilian Apennines.

Materials and methods

The field work was carried out on 21–23 July, 2018 in areas falling in the Emilia-Romagna in the localities Passo della Scalucchia, Buca del Moro, Mt. Cavalbianco, Lago della Bargetana, and Mt. Prado, at altitudes between 1,350 and 2,056 m a.s.l. The collections were made from soil, rocks, rocky crevices, tree bark, and rotting stumps in different habitats (beech woods, heathlands with *Vaccinium* sp. pl., snow-beds, peat bogs, stream banks). The following 13 sites were investigated and sampled:

- 1 Passo della Scalucchia, beech wood, 1,350 m a.s.l., 44°21'25"N, 10°13'44"E
- 2 Buca del Moro, beech wood, 1,450 m a.s.l., 44°20'32"N, 10°12'59"E
- 3 Mt. Cavalbianco, beech wood, 1,575 m a.s.l., 44°17'10"N, 10°17'59"E
- 4 Mt. Cavalbianco, beech wood, 1,590 m a.s.l., 44°17'27"N, 10°17'55"E
- 5 Mt. Cavalbianco, beech wood, 1,600 m a.s.l., 44°17'38"N, 10°18'00"E
- 6 Mt. Cavalbianco, heathland, 1,650 m a.s.l., 44°18'05"N, 10°17'50"E

- 7 Mt. Cavalbianco, streams in the beech wood beyond the heathland, 1,450 m a.s.l., 44°18'24"N, 10°18'31"E
- 8 Lago della Bargetana, 1,740 m a.s.l., 44°15'28.9"N, 10°24'06.5"E
- 9 Lago della Bargetana, 1,750 m a.s.l., 44°15'18"N, 10°24'16"E
- 10 Lago della Bargetana, peat bog, 1,770 m a.s.l., 44°15'18"N, 10°24'17"E
- 11 Lago della Bargetana, peat bog, 1,780 m a.s.l., 44°15'18.6"N, 10°24'20"E
- 12 Lago della Bargetana, heathland, 1,820 m a.s.l., 44°15'09"N, 10°24'22"E
- 13 Mt. Prado, snow-beds, 2,056 m a.s.l., 44°14'58"N, 10°24'26"E

Taxa (genera and species) are arranged in alphabetical order mainly following the classification proposed by Goffinet et al. (2009). The nomenclature follows Ros et al. (2013), Plášek et al. (2015), and Lara et al. (2016) for mosses and Söderström et al. (2016) for liverworts.

The specimens are kept in CAME, CAG, SIENA, and in the personal herbaria of the authors.

Results

Floristic list

The bryophyte taxa collected in the investigated areas are listed below. The taxa followed by ** are new reports for Emilia-Romagna; the taxa followed by * are confirmations for the Region. For each taxon, the localities and habitat within the study area are reported.

MARCHANTIIDAE

JUNGERMANNIALES

Cephaloziaceae

Cephalozia bicuspidata (L.) Dumort. – Site 11: in the peat bog.

Cephaloziellaceae

Cephaloziella baumgartneri Schiffn. – Site 5: on soil and in rocky crevices in the beech wood.

Jungermanniaceae

Jungermannia atrovirens Dumort. – Site 5: on soil and in rocky crevices.

Lophocoleaceae

Chiloscyphus pallescens (Ehrh.) Dumort. – Site 12: on soil.

**Chiloscyphus polyanthos* (L.) Corda – Site 8: on damp soil along a stream; site 10: in the peat bog.

Lophocolea heterophylla (Schrad.) Dumort. – Sites 1, 5: on rotting stumps in the beech wood.

Plagiochilaceae

Plagiochila asplenoides (L.) Dumort. – Site 1: on rocks.

Plagiochila porelloides (Torr. ex Nees) Lindenb. – Sites 3, 4: on soil in the beech wood, on bark of *Fagus sylvatica*; site 8: on peaty soil, along a stream.

Pseudolepicoleaceae

Blepharostoma trichophyllum (L.) Dumort. – Site 9: along a stream.

Scapaniaceae

Barbilophozia barbata (Schmidel ex Schreb.) Loeske – Site 6: on humus among boulders in the heathlands with *Vaccinium* sp. pl.

Barbilophozia hatcheri (A. Evans) Loeske – Site 8: in rocky crevices.

Barbilophozia lycopodioides (Wallr.) Loeske – Site 1: on rocks in the beech wood; site 6: on humus among boulders in the heathlands with *Vaccinium* sp. pl.

Lophozia ventricosa (Dicks.) Dumort. – Site 11: on peaty soil; Site 13: on soil in a snow-bed.

Lophozia wenzelii (Nees) Steph. – Site 8: on peaty soil.

Mesoptychia turbinata (Raddi) L.Söderstr. et Váňa – Sites 1,2: on soil; site 4: on humus among boulders in the heathlands with *Vaccinium* sp. pl.

**Scapania irrigua* (Nees) Nees – Site 5: on soil and rotting stumps in the beech wood.

***Scapania uliginosa* (Lindenb.) Dumort. – Site 8: on peaty soil.

Trilophozia quinquedentata (Huds.) Bakalin – Site 12: on soil.

PORELLALES

Frullaniaceae

Frullania dilatata (L.) Dumort. – Site 4: on rotting stumps.

**Frullania tamarisci* (L.) Dumort. var. *tamarisci* – Site 4: on soil.

Porellaceae

Porella platyphylla (L.) Pfeiff. – Site 1: on soil at the edge of the beech wood; site 2: on rocks in the beech wood; site 3: on bark of *Fagus sylvatica*.

Radulaceae

Radula complanata (L.) Dumort. – Site 1: on bark of *Fagus sylvatica*; sites 3,4: on bark of *Fagus sylvatica*; site 7: along a stream.

Radula lindbergiana Gottschs ex C. Hartm. – Site 2: on rotting stumps in the beech wood.

METZGERIALES

Aneuraceae

Aneura pinguis (L.) Dumort. – Site 10: in the peat bog.

BRYIDAE

SPHAGNALES

Sphagnaceae

Sphagnum capillifolium (Ehrh.) Hedw. – Site 8,10: in the peat bog.

Sphagnum teres (Schimp.) Ångstr. – Site 8: in a swamp.

POLYTRICHALES

Polytrichaceae

Atrichum undulatum (Hedw.) P. Beauv. – Sites 3,4: on soil in the beech wood.

Pogonatum aloides (Hedw.) P. Beauv. – Site 4: on soil in the beech wood (forest path escarpment); site 13: in a snow-bed.

Pogonatum urnigerum P. Beauv. – Site 2: on soil in the beech wood.

Polytrichastrum alpinum (Hedw.) G.L.Sm. – Sites 1,2: on rocks and soil in the beech wood; site 3,4: on soil and rocky crevices in the beech wood; site 6: on humus among boulders in the heathlands with *Vaccinium* sp. pl.; site 8,9: in rocky crevices.

Polytrichum formosum Hedw. – Site 4: on soil in the beech wood; site 6: on humus among boulders in the heathlands with *Vaccinium* sp. pl.; site 9: on soil.

Polytrichum juniperinum Hedw. – Sites 5,6: on humus among boulders in the heathlands with *Vaccinium* sp. pl.

Polytrichum piliferum Hedw. – Site 1,5: on soil; site 4: on soil in the beech wood; site 6: on soil and humus among boulders in the heathlands with *Vaccinium* sp. pl.; site 13: on soil in a snow-bed.

BARTRAMIALES

Bartramiaceae

Philonotis calcarea (Bruch & Schimp.) Schimp. – Sites 8,9: on peaty soil; site 12: on soil in the heathland.

Philonotis fontana (Hedw.) Brid. – Site 8: along a stream edge; site 10: in the peat bog.

*******Philonotis rigida* Brid. – Site 12: on soil in the heathland.

Philonotis seriata Mitt. – Sites 8: on peaty soil; site 10: along a streamlet in the bog.

BRYALES

Bryaceae

Bryum schleicheri DC. – Site 10: along a streamlet in the bog; site 12: on soil in the heathland.

Bryum tenuisetum Limpr. – Site 13: on soil in a snow-bed.

Imbribryum mildeanum (Jur.) J.R. Spence – Site 13: on soil in a snow-bed.

Ptychostomum pallens (Sw.) J.R. Spence – Site 8: on peaty soil.

Ptychostomum pseudotriquetrum (Hedw.) J.R. Spence & H.P.Ramsay var. *pseudotriquetrum* – Site 8: on peaty soil.

Mniaceae

Mnium marginatum (Dicks.) P.Beauv. var. *marginatum* – Site 7: on damp soil.

Mnium spinulosum Bruch & Schimp. – Site 1: on soil; site 6: on humus among boulders in the heathlands with *Vaccinium* sp. pl.

Plagiomnium undulatum (Hedw.) T.J.Kop. var. *undulatum* – Site 7: on moist soil along streams.

Pohlia cruda (Hedw.) Lindb. – Site 7: on moist soil along streams.

*******Rhizomnium pseudopunctatum* (Bruch & Schimp.) T.J.Kop. – Site 9: on moist soil.

Rhizomnium punctatum (Hedw.) T.J.Kop. – Site 5: on soil in the beech wood; site 7: on moist soil along streams.

DICRANALES

Dicranaceae

Dicranella heteromalla (Hedw.) Schimp. – Site 6: on humus among boulders in the heathlands with *Vaccinium* sp. pl.

Dicranella subulata (Hedw.) Schimp. – Site 9: in rocky crevices.

Dicranum majus Sm. – Site 9: on soil in the beech wood.

Dicranum scoparium Hedw. – Site 1: on soil; site 6: on humus among boulders in the heathlands with *Vaccinium* sp. pl.

Dicranum cfr. *tauricum* Sapjegin – Site 8: in rocky crevices.

Ditrichaceae

Ceratodon purpureus (Hedw.) Brid. – Site 1: on dry soil; site 2: on soil at the edge of the beech wood.

Fissidentaceae

******Fissidens pusillus* (Wilson) Milde – Site 7: on soil along streams.

Rhabdoweisiaceae

Dicranoweisia cirrata (Hedw.) Lindb. – Site 6: on soil among boulders in the heathlands with *Vaccinium* sp. pl.

Hymenoloma crispulum (Hedw.) Ochyra – Site 6: on soil among boulders in the heathlands with *Vaccinium* sp. pl.

Kiaeria starkei (F.Weber & D.Mohr) I. Hagen – Site 9: in rocky crevices.

DIPHYSCIALES

Diphysciaceae

Diphyscium foliosum (Hedw.) D.Mohr – Sites 3,4: on soil in the beech wood.

GRIMMIALES

Grimmiaceae

*****Grimmia lisae*** De Not. – Site 1: on rocks in the beech wood.

Racomitrium elongatum Ehrh. ex Frisvoll – Site 1: on soil in the beech wood.

*****Racomitrium fasciculare*** (Hedw.) Brid. – Site 6: on humus among boulders in the heathlands with *Vaccinium* sp. pl.; site 13: on soil in a snow-bed.

Racomitrium lanuginosum (Hedw.) Brid. – Site 6: on humus among boulders and rocks in the heathlands with *Vaccinium* spp; site 9: on soil.

Schistidium apocarpum (Hedw.) Bruch & Schimp. – Site 1: on rocks; site 6: among boulders in the heathlands with *Vaccinium* sp. pl.

HYPNALES

Amblystegiaceae

Campylium protensum (Brid.) Kindb. – Site 12: on soil.

Campylium stellatum (Hedw.) Lange & C.E.O. Jensen – Site 8: along a streamlet in the bog, on peaty soil; site 11: on peaty soil.

Hygrohypnum luridum (Hedw.) Jenn. – Site 8: on peaty soil.

Palustriella commutata (Hedw.) Ochyra – Site 7: along a stream.

Palustriella falcata (Brid.) Hedenäs – Site 11: in a peat bog.

Sanionia uncinata (Hedw.) Loeske – Site 8: on peaty soil.

*****Scorpidium cossonii*** (Schimp.) Hedenäs – Site 8: on peaty soil.

Anomodontaceae

Anomodon attenuatus (Hedw.) Huebener – Site 1: on soil in the beech wood.

Brachytheciaceae

Brachytheciastrum velutinum (Hedw.) Ignatov & Huttunen var. ***velutinum*** – Site 1: on soil in the beech wood.

Brachythecium campestre (Müll. Hal.) Schimp. – Site 4: on soil in the beech wood.

Brachythecium rutabulum (Hedw.) Schimp. – Site 4: on rotting stumps in the beech wood.

****Brachythecium cirrosum*** (Schwägr.) Schimp. – Site 6: on humus among boulders in the heathlands with *Vaccinium* sp. pl.

Homalothecium sericeum (Hedw.) Schimp. – Sites 1,3,4,5: on bark of *Fagus sylvatica*; Site 2: on soil in beech wood.

Kindbergia praelonga (Hedw.) Ochyra – Sites 3,4: along streams.

Rhynchostegium confertum (Dicks) Schimp. – Site 2: on bark at the base of *Fagus sylvatica*.

Rhynchostegium riparioides (Hedw.) Cardot – Site 7: in a stream.

Scorpiurium circinatum (Bruch) M.Fleisch. & Loeske – Site 4: on soil.

Calliergonaceae

Sarmentypnum exannulatum (Schimp.) Hedenäs – Site 8: on peaty soil.

Straminergon stramineum (Dicks. ex Brid.) Hedenäs – Site 8: in a bog.

Climaciaceae

Climacium dendroides (Hedw.) F.Weber & D.Mohr – Site 8: on peaty soil.

Hylocomiaceae

Hylocomium splendens (Hedw.) Schimp. – Site 8: on soil.

Rhytidiadelphus squarrosus (Hedw.) Warnst. – Site 6: on humus among boulders in the heathlands with *Vaccinium* sp.pl.

Rhytidiadelphus triquetrus (Hedw.) Warnst. – Site 6: on humus among boulders in the heathlands with *Vaccinium* sp. pl.

Hypnaceae

Campylophyllum halleri (Hedw.) M.Fleisch. – Sites 1,2: on rocks in the beech wood.

Herzogiella seligeri (Brid.) Z. Iwats – Site 4: on soil in the beech wood.

Hypnum cupressiforme Hedw. var. *cupressiforme* – Site 1: on bark of *Fagus sylvatica*, on soil and rocks in the beech wood; sites 3,4,5: on bark of *Fagus sylvatica*.

Leskeaceae

Lescuraea incurvata (Hedw.) E.Lawton – Site 5: on soil in the beech wood.

Lescuraea radicata (Mitt.) Mönk. – Site 4: on rotting stumps.

**Lescuraea saxicola* (Schimp.) Molendo – Site 5: on rocks in the beech wood.

Pseudoleskeella nervosa (Brid.) Nyholm – Site 5: on soil in the beech wood.

Leucodontaceae

Leucodon sciuroides (Hedw.) Schwägr. – Sites 1,2: on bark of *Fagus sylvatica*.

Plagiotheciaceae

Plagiothecium denticulaum (Hedw.) Schimp. var. *denticulatum* – Sites 1,4,5: on rotting stumps in the beech wood.

Plagiothecium laetum Schimp. – Site 5: on rocks in the beech wood.

Pterigynandraceae

***Habrodon perpusillus* (De Not.) Lindb. – Site 2: on rotting stumps in beech wood.

**Heterocladium dimorphum* (Brid.) Schimp. – Site 2: on humus among boulders in the heathlands with *Vaccinium* sp. pl.

Myurella julacea (Schwägr.) Schimp. – Site 6: on humus among boulders in the heathlands with *Vaccinium myrtillus*.

Myurella tenerrima (Brid.) Lindb. – Site 4: on soil in beech wood.

Pterigynandrum filiforme Hedw. – Site 1: on bark of *Fagus sylvatica*, on rotting stumps; sites 3,4,7: on bark of *Fagus sylvatica*, on soil; site 13: on soil in a snow-bed.

Thuidiaceae

Abietinella abietina (Hedw.) M.Fleisch. var. *abietina* – Sites 1,2: on soil in the beech wood.

Thuidium delicatulum (Hedw.) Schimp. – Site 7: on soil along streams.

Thuidium tamariscinum (Hedw.) Schimp. – Site 7: on soil.

ORTHOTRICHALES

Orthotrichaceae

Lewinskya affinis (Schrader ex Brid.) F.Lara, Garilleti & Goffinet – Sites 3,4: on bark of *Fagus sylvatica*.

Pulviger a lyellii (Hook. & Taylor) Plášek, Sawicki & Ochyra – Sites 3,4: on bark of *Fagus sylvatica*.

****Orthotrichum pulchellum** Brunt. – Sites 3,4: on bark of *Fagus sylvatica*.

Orthotrichum striatum Hedw. – Sites 1,3,4: on bark of *Fagus sylvatica*.

Orthotrichum cfr. *tenellum* Bruch ex Brid. – Sites 3,5: on bark of *Fagus sylvatica*.

POTTIALES

Pottiaceae

Didymodon acutus (Brid.) K.Saito – Site 6: on humus among boulders in the heathlands with *Vaccinium myrtillus*.

Syntrichia ruralis (Hedw.) F.Weber & D.Mohr var. *ruralis* – Site 1: on rocks in the beech wood.

Tortula muralis Hedw. – Site 13: on soil in a snow-bed.

RHIZOGONIALES

Aulacomniaceae

Aulacomnium palustre (Hedw.) Schwägr. – Site 12: in a peat bog.

Discussion

The result of this survey is a checklist of 113 taxa (24 liverworts and 89 mosses), including eight records that, on the basis of data reported by Fariselli et al. (2019), are new for the Emilia-Romagna Region. Some of them are of phytogeographical interest and deserve a special protection over time. In particular, *Scapania uliginosa*, which is a circumpolar Arctic montane species very rare in Europe (Ros et al. 2007), is reported here for the first time in Emilia-Romagna. The new moss records for this Region are *Grimmia lisae*, *Harodon perpusillus*, *Orthotrichum pulchellum*, *Philonotis rigida*, *Racomitrium fasciculare*, *Rhizomnium pseudopunctatum*, and *Scorpidium cossonii*. Amongst these, we highlight, for their rarity in Italy, *Rhizomnium pseudopunctatum*, *Racomitrium fasciculare*, and *Scorpidium cossonii*, reported only for few northern Regions (Aleffi et al. 2008). Particularly interesting is the finding of *Orthotrichum pulchellum*, which has been reported in Italy only from Lombardia, Calabria, and Sicilia (Aleffi et al. 2008). In addition to these in-

teresting new records, the occurrence of seven species is confirmed for Emilia-Romagna: *Chiloscyphus polyanthos*, *Scapania irrigua*, and *Frullania tamarisci* among the liverworts, *Brachythecium cirrosum*, *Fissidens pusillus*, *Heterocladium dimorphum*, and *Lescuraea saxicola*, among the mosses. In particular, *Brachythecium cirrosum* deserves to be mentioned because it is an European bryophyte that is probably threatened by climate change; although it is not actually at risk, conservation measures for this taxon are recommended (Schnyder 2019). Overall, the most widespread species recorded by us are: *Plagiochila porelloides*, *Homalothecium sericeum*, *Hypnum cupressiforme* var. *cupressiforme*, *Polytrichastrum alpinum*, *Polytrichum piliferum*, and *Pterigynandrum filiforme*.

Based on the results of this survey, the bryophyte flora in the investigated area shows a liverwort/moss ratio of 0.269, with a scarce liverwort component, comparable with that of Monte Bondone (Trentino-Alto Adige), which is 0.256 (Privitera et al. 2010). Within mosses, the pleurocarpous/acrocarpous ratio is 0.87, a very high value considering the numerical superiority of the acrocarpous mosses. This is likely due to the occurrence, in the investigated sites (most of them within beech woods), of species that are well adapted to the forest ecosystem. Liverworts belong to 11 families, and mosses to 26; in particular, the most represented moss families are Brachytheciaceae (10.3%) Amblystegiaceae and Polytrichaceae (9.0% each one), followed by Mniaceae (6.8%) and then by Dicranaceae, Grimmiaceae, Orthotrichaceae and Pterygindraceae (5.7% each). The scarce presence of the Pottiaceae (3.4%) is not surprising, since the family is widespread in Mediterranean territories (Privitera et al. 2015; Puglisi et al. 2015; Puglisi and Cataldo 2019).

As regards the phytogeographical analysis (Hill and Preston 1998), the boreal-temperate species prevail (30.7%), followed at a distance by boreal-arctic montane (16.2%), boreal-montane (11.7%), and temperate species (10.8%); the least represented categories are the Mediterranean (5.4%) and wide-temperate (2.7%).

In conclusion, this study reveals a rich bryophyte diversity in the investigated area, with a significant number of species that are rare for Italy. For this reason, and as previously highlighted for other mountain areas (Puglisi et al. 2013; Ellis et al. 2017), the Apennines can be considered an important site for biodiversity conservation, surely less affected by human disturbance, one of the most dangerous causes of biodiversity loss.

References

- Aleffi M, Tacchi R, Cortini Pedrotti C (2008) Check-list of the Hornworts, Liverworts and Mosses of Italy. *Bocconea* 22: 1–256.
- Aleffi M, Pellis G, Puglisi M (2014) The bryophyte flora of six gypsum outcrops in the Northern Apennines (Nature 2000 Network, Emilia-Romagna Region, Italy). *Plant Biosystems* 148(4): 825–836. <https://doi.org/10.1080/11263504.2014.949331>
- Avetta C (1897) Flora crittogamica della Provincia di Parma. *Malpighia* 11: 181–197.
- Barsali E (1907) Censimento delle epatiche toscane. *Nuovo Giornale Botanico Italiano*, n.s. 14: 5–49.

- Barsali E (1914) Frammenti d'epaticologia italiana. *Bullettino della Società Botanica Italiana* 5: 41–44.
- Bottini A (1913) Spigolature briologiche N. 2. *Atti della Società Toscana di Scienze Naturali, Memorie*, Pisa 22: 149–195.
- Bottini A (1914) Spigolature briologiche N. 3. *Atti della Società Toscana di Scienze Naturali, Memorie*, Pisa 23: 37–43.
- Bottini A (1919) Sfagnologia italiana. *Mem. Accad. Lincei*. 13: 1–87.
- Bruni P, Cipriani N, Pandeli E (1994) New sedimentological and petrographical data on the Oligo-Miocene turbiditic formations of the Tuscan Domain. *Memorie Società Geologica Italiana* 48: 251–260.
- Casali C (1899a) Aggiunte alla flora crittogamica del Reggiano. *Bullettino della Società Botanica Italiana* 5–6: 93–96.
- Casali C (1899b) *Le Briofite del Reggiano*. Avellino, 35 pp.
- Ellis LT, Afonina OM, Andriamiarisoa RL, Bednarek-Ochyra H, Cykowska-Marzencka B, Stryjak-Bogacka M, Bell NE, Boiko M, Callaghan DA, Campisi P, Dia MG, Marino ML, Provenzano F, Eckstein J, Enroth J, Erzberger P, Ezer T, Gargano ML, Ginzburg E, Górski P, Gradstein SR, Reeb C, Hannoire C, Infante M, Jukonienė I, Kushnevskaya EV, Lebouvier M, Nagy J, Opmanis A, Plášek V, Skoupá Z, Sabovljević MS, Sabovljević AD, Shevock R, Singh DK, Majumdar S, Skudnik M, Uselienė A, Venturella G, Węgrzyn M, Wietrzyk P, Yoon Y J, Kim JH, Yücel E (2017) New national and regional bryophyte records, 53. *Journal of Bryology*, 39(4): 368–387. <https://doi.org/10.1080/03736687.2017.1384204>
- Fariselli R, Aleffi M, Speranza M (2019) *Check List delle Briofite dell'Emilia-Romagna*. Alma Mater Studiorum, Università di Bologna, 168 pp.
- Ferrari C, Piccoli F (1997) The ericaceous dwarf shrublands above the Northern Apennines timberline (Italy). *Phytocoenologia* 27: 53–76. <https://doi.org/10.1127/phyto/27/1997/53>
- Fiori A (1886) Muschi del Modenese e del Reggiano. I^a Contribuzione. *Atti della Società dei Naturalisti di Modena, Memorie* 5: 127–179.
- Fiori A (1892a) *Rivista statistica dell'Epaticologia Italiana*. Primo elenco delle Epatiche del Modenese e Reggiano. *Malpighia* 6: 41–49.
- Fiori A (1892b) Seconda contribuzione alla Briologia Emiliana. *Malpighia* 6: 564–570.
- Gennai M, Foggi B, Viciani D, Carbognani M, Tomaselli M (2014) The *Nardus*-rich communities in the northern Apennines (N-Italy): a phytosociological, ecological and phytogeographical study. *Phytocoenologia* 44: 55–80. <https://doi.org/10.1127/0340-269X/2014/0044-0574>
- Gerdol R, Tomaselli M (1988) Phytosociology and ecology of stream vegetation in the summit region of the northern Apennines. *Bollettino del Museo di Storia Naturale della Lunigiana* 6–7: 89–93.
- Gerdol R, Tomaselli M (1993) The vegetation of wetlands in the northern Apennines (Italy). *Phytocoenologia* 21(4): 421–469. <https://doi.org/10.1127/phyto/21/1993/421>
- Goffinet B, Buck WR, Shaw AJ (2009) Morphology, anatomy, and classification of the Bryophyta. In: Goffinet B, Shaw AJ (Eds) *Bryophyte Biology*, 2nd edn. Cambridge, Cambridge University Press, 55–138.
- Hill MO, Preston CD (1998) The geographical relationship of British and Irish bryophytes. *Journal of Bryology* 20: 127–226. <https://doi.org/10.1179/jbr.1998.20.1.127>

- Hodgetts NG (2015) Check list and Country status of European bryophytes – towards a new Red List for Europe. Irish Wildlife Manuals, No. 84. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Ireland, 1–125.
- Lara F, Garilleti R, Goffinet B, Draper I, Medina R, Vigalondo B, Mazimpaka V (2016) *Lewinskya*, a new genus to accommodate the phaneroporous and monoicous taxa of *Orthotrichum* (Bryophyta, Orthotrichaceae). *Cryptogamie, Bryologie* 37(4): 361–382. <https://doi.org/10.7872/cryb/v37.iss4.2016.361>
- Petraglia A, Tomaselli M (2007) Phytosociological study of the snowbed vegetation in the Northern Apennines (Northern Italy). *Phytocoenologia* 37(1): 67–98. <https://doi.org/10.1127/0340-269X/2007/0037-0067>
- Plášek V, Sawicki J, Ochyra R, Szczecińska M, Kulik T (2015) New taxonomical arrangement of the traditionally conceived genera *Orthotrichum* and *Ulota* (Orthotrichaceae, Bryophyta). *Acta Musei Silesiae, Scientiae Naturales* 64: 169–174. <https://doi.org/10.1515/cszma-2015-0024>
- Privitera M, Aleffi M, Bertani G, Campisi P, Carratello A, Codogno M, Cogoni A, Miserere L, Perego S, Puglisi M, Sguazzin F, Tacchi R, Zimbone A (2010) Survey of the bryophyte diversity of the Carnic Alps, including some interesting records for the Italian bryoflora. *Flora Mediterranea* 20: 193–209.
- Privitera M, Galesi R, Arato L, Puglisi M (2015) Bryophyte diversity in Augusta-Priolo territory (South-Eastern Sicily). *Flora Mediterranea* 25 (special issue): 115–126. <https://doi.org/10.7320/FlMedit25SI.115>
- Provasi T (1938) Florula dei Laghetti dell'Appennino Parmense e Reggiano. *Nuovo Giornale Botanico Italiano*, n.s. 45(2). <https://doi.org/10.1080/11263503809439757>
- Puglisi M, Campisi P, Aiello P, Dia MG, Privitera M (2015) Analysis of the bryophyte diversity of mountain ranges in Sicily. *Nova Hedwigia* 100(3–4): 391–405. https://doi.org/10.1127/nova_hedwigia/2015/0236
- Puglisi M, Campisi P, Lakušić D, Surina B, Di Pietro R, Privitera M (2013) Notes on the bryophyte flora and vegetation of the central and south-western Balkans. *Lazaroa* 34: 107–116. https://doi.org/10.5209/rev_LAZA.2013.v34.n1.42334
- Puglisi M, Cataldo D (2019) A comparative study on the bryophyte and lichen flora for monitoring the conservation status of protected areas of Sicily. *Nova Hedwigia* 109(3–4): 321–343. https://doi.org/10.1127/nova_hedwigia/2019/0550
- Raffaelli M (1976) Gli Sfagni Tosco-Emiliani. *Webbia* 30(1): 159–175. <https://doi.org/10.1080/00837792.1976.10670046>
- Smith AJE (2004) *The Moss Flora of Britain and Ireland*. Cambridge University Press, 1012 pp. <https://doi.org/10.1017/CBO9780511541858>
- Ros RM, Mazimpaka V, Abou-Salama U, Aleffi M, Blockeel T-L, Brugués M, Cano MJ, Cros RM, Dia MG, Dirkse GM, El Saadawi W, Erdağ A, Ganeva A, Gonzalez-Mancebo JM, Herinhardt I, Khalil K, Kürschner H, Lanfranco E, Losada-Lima A, Refai MS, Rodriguez-Núñez S, Sabovijević M, Sérgio C, Shabbara H, Sim-Sim M, Söderström L (2007) Hepatics and Anthocerotales of the Mediterranean, an annotated checklist. *Cryptogamie, Bryologie* 28(4): 351–437.
- Ros RM, Mazimpaka V, Abou-Salama U, Aleffi M, Blockeel TL, Brugués M, Cros RM, Dia MG, Dirkse GM, Draper I, El-Saadawi W, Erdağ A, Ganeva A, Gabriel R, González-Mancebo JM,

- Granger C, Herrnstadt I, Hugonnot V, Khalil K, Kürschner H, Losada-Lima A, Luís L, Mifsud S, Privitera M, Puglisi M, Sabovljević M, Sérgio C, Shabbara HM, Sim-Sim M, Sotiaux A, Tacci R, Vanderpoorten A, Werner O (2013) Mosses of the Mediterranean, an annotated checklist. *Cryptogamie, Bryologie* 34: 99–283. <https://doi.org/10.7872/cryb.v34.iss2.2013.99>
- Schnyder N (2019) *Brachythecium cirrosum*. The IUCN Red List of Threatened Species 2019: e.T88148732A88382488 [Downloaded on 13 November 2019]
- Söderström L, Hagborg A, Von Konrat M, Bartholomew-Began S, Bell D, Briscoe L, Brown E, Cargill DC, Costa DP, Crandall-Stotler BJ, Cooper ED, Dauphin G, Engel JJ, Feldberg K, Glenny D, Gradstein SR, He X, Heinrichs J, Hentschel J, Ilkiu-Borges AL, Katagiri T, Konstantinova NA, Larraín J, Long DG, Nebel M, Pócs T, Puche F, Reiner-Drehwald E, Renner MAM, Sass-Gyarmati A, Schäfer-Verwimp A, Segarra Moragues JG, Stotler RE, Sukkharak P, Thiers BM, Uribe J, Váňa J, Villarreal JC, Wigginton M, Zhang L, Zhu R-L (2016) World checklist of hornworts and liverworts. *Phytokeys* 59: 1–828. <https://doi.org/10.3897/phytokeys.59.6261>
- Tomaselli M (1991) The snow-bed vegetation in the Northern Apennines. *Vegetatio* 94: 177–189. <https://doi.org/10.1007/BF00032630>
- Tomaselli M, Gerdol R (1984) Analisi e valutazione fitogeografico-ecologica della distribuzione di alcune orofite appartenenti alla flora igrofila dell'alto Appennino tosco-emiliano. *Atti dell'Istituto Botanico e Laboratorio Crittogamico dell'Università di Pavia, Serie 7(2)* (1983): 107–146.
- Tomaselli M, Rossi G, Dowgiallo G (2000) Phytosociology and ecology of the *Festuca puccinellii*-grasslands in the northern Apennines (N-Italy). *Botanica Helvetica* 110(2): 125–149.
- Tomaselli M, Foggi B, Carbognani M, Gennai M, Petraglia A (2019) The rock-face vegetation in the northern Apennines and neighbouring mountain areas, from the coast line to the highest summits. *Phytocoenologia* 49: 7–70. <https://doi.org/10.1127/phyto/2018/0117>
- Ubaldi D, Zanolini AL, Puppi G (1993) Les paysages forestiers de l'Emilie-Romagne et leur signification bioclimatique. *Colloques Phytosociologiques* 21: 269–286.